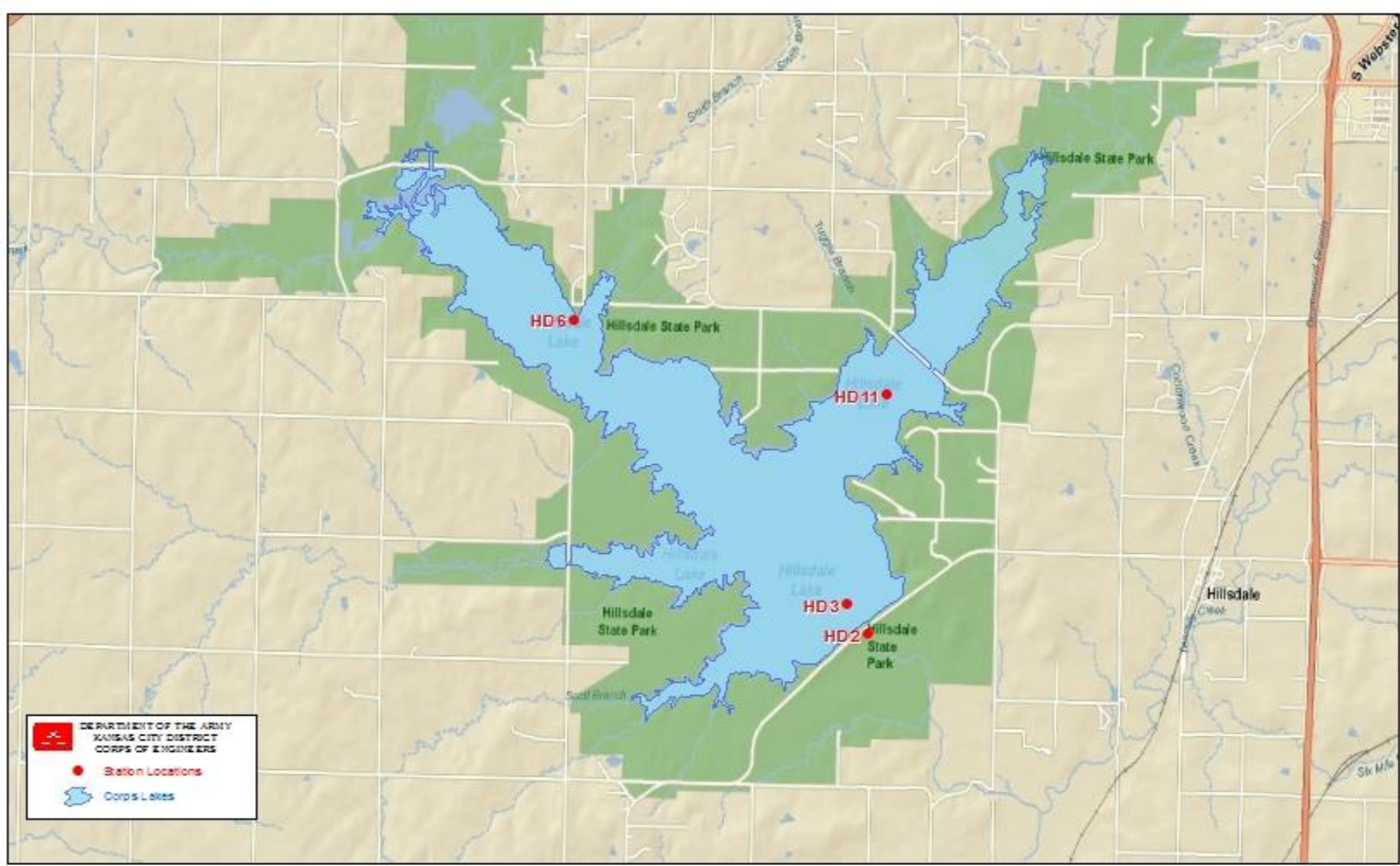


Hillsdale Lake Water Quality Summary

2006-2015

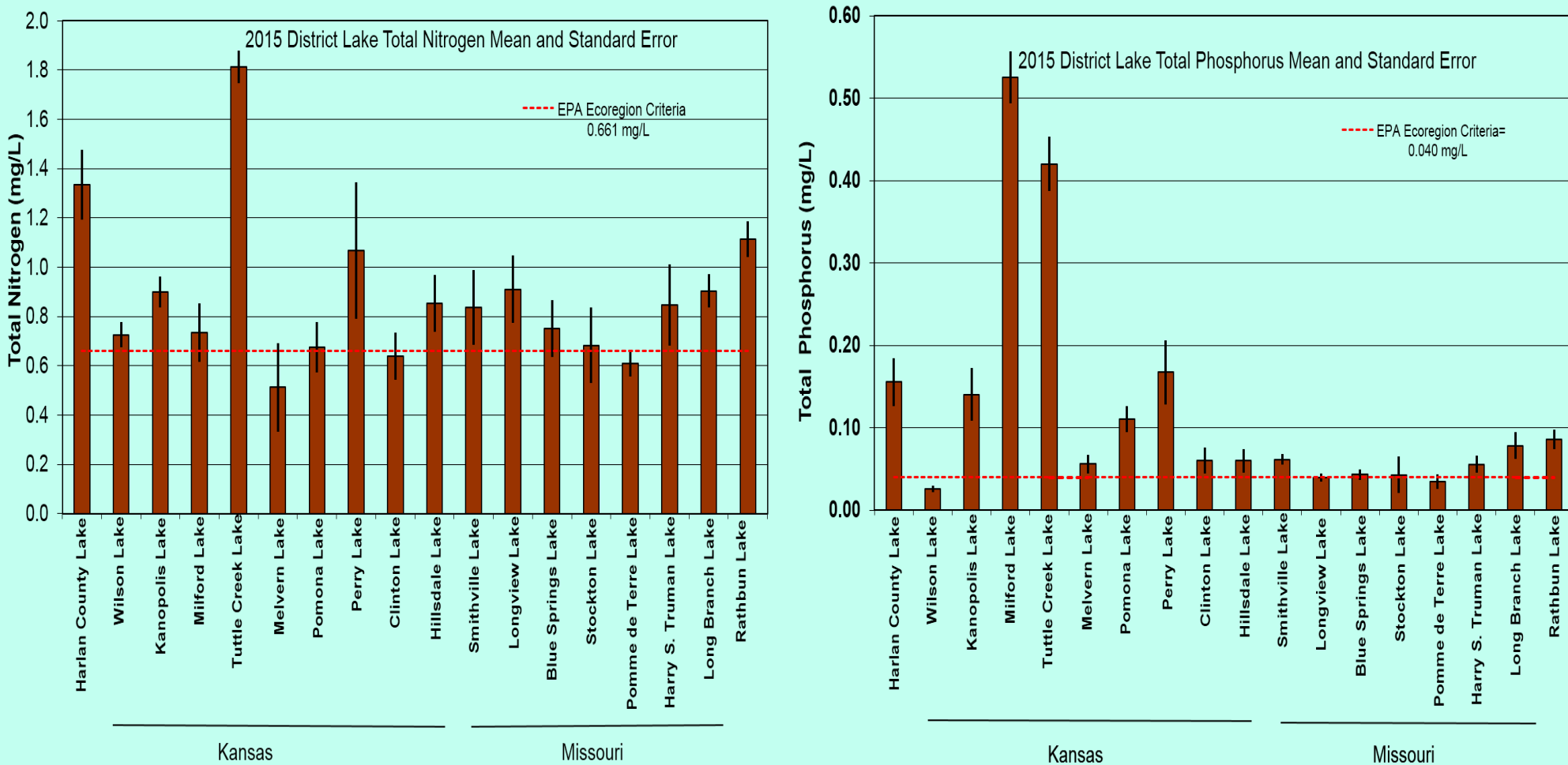


Hillsdale Lake:

- Built on Big Bull Creek 29.1 km (18.2 miles) upstream of the confluence of Marais des Cygnes River
- **Watershed** = 144 sq miles (92,160 Acres)
- **Capacity:**
 - Flood Control: 83,000 Acre Feet (AF); 7,413 surface acres (SA)
 - Multipurpose: 76,300 AF; 4,575 SA; 51 miles of shoreline
- **Operating project purposes:** flood control, water quality, recreation, fish and wildlife, and water supply.
- **Avg. annual inflow** (2006-2015)= 79,274 AF; **2015 inflow**= 129,897 AF
- **Water Quality** at Hillsdale Lake showed an increase in phosphorus and experienced a short blue-green algae bloom resulting from a large phosphorus load entering with inflows 163% larger than 10-year average. Water quality was beneficial to authorized purposes for Hillsdale Lake.

Nutrient Enrichment

Nutrients (i.e. phosphorus and nitrogen) are essential for aquatic life and are the primary factor driving fish and aquatic plant growth rates and productivity. Excess nutrients from urban, agricultural or natural sources increases the natural aging or eutrophication process in lakes. This can alter plant and aquatic life in lakes and water bodies, cause algal blooms, create low dissolved oxygen that affect fish survival, and lead to taste and odor issues in drinking water. Hillsdale Lake is on the approved 2016 Ks 303(d) list of impaired waters due to eutrophication. EPA and KDHE are working with water quality partners and landowners to focus watershed conservation efforts on priority or target areas in the watershed to reduce nutrient and sediment runoff. This approach is designed to improve water quality and reduce designated impairments at Hillsdale Lake. In 2015, Hillsdale Lake averages were less than USACE Kansas City District lake averages for total phosphorus (0.12 mg/L) but exceeded the District lake average for total nitrogen (0.8 mg/L). Standard error bars in the graphs below illustrate the variation in sample results for all Kansas City District lakes in 2015.

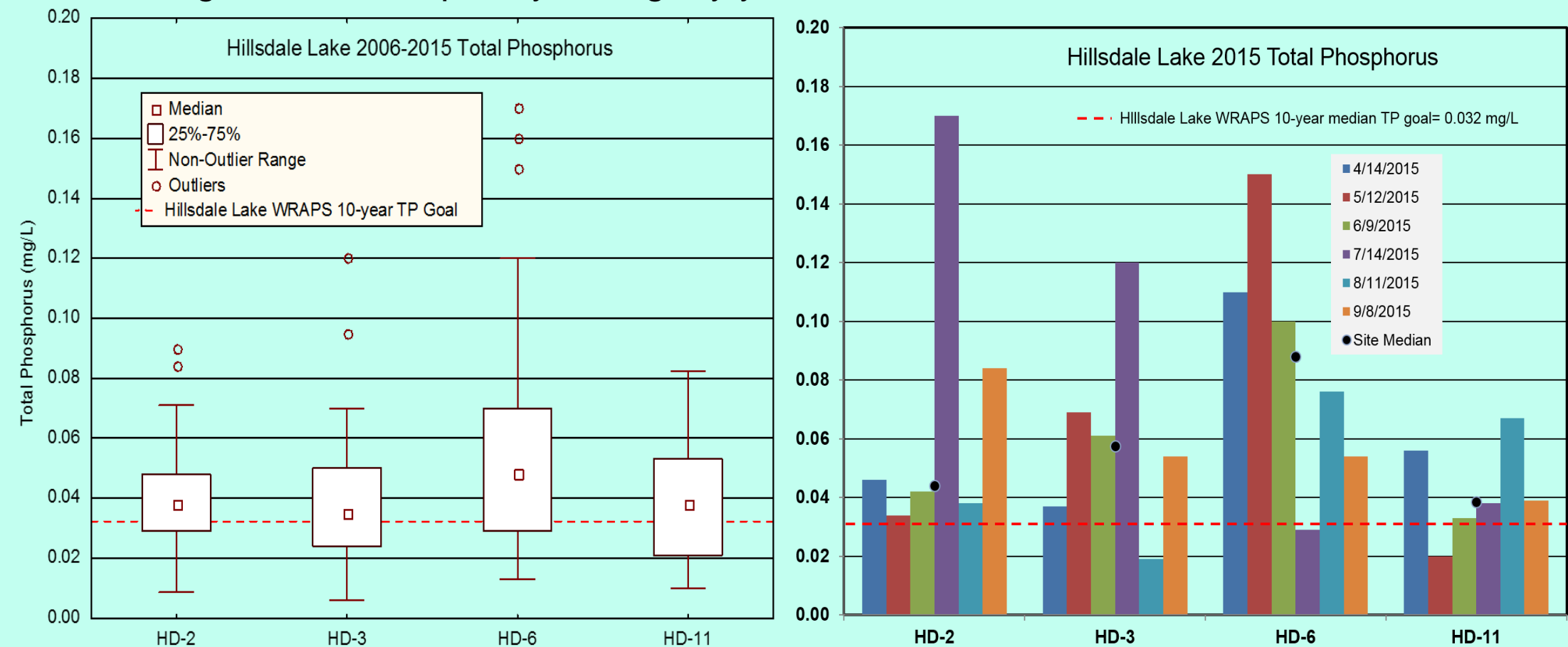


The **US Army Corps of Engineers** (USACE) Water Quality Program collects monthly water samples at Hillsdale Lake* from April through September. These figures present data collected between 2005-2014 from lake sites (#3, 6, 11), and the outflow (#2) below the dam. Thirty-four chemical, physical and biological parameters are measured to evaluate water quality. USACE uses this data to describe water quality history, conditions and changes from the inflow streams, within the main lake, and outflow focusing on eutrophication, nutrients, sediment, herbicides, metals, and contaminants.

*Note: The term "lake" is substituted for technically correct "reservoir" throughout this document for consistency.

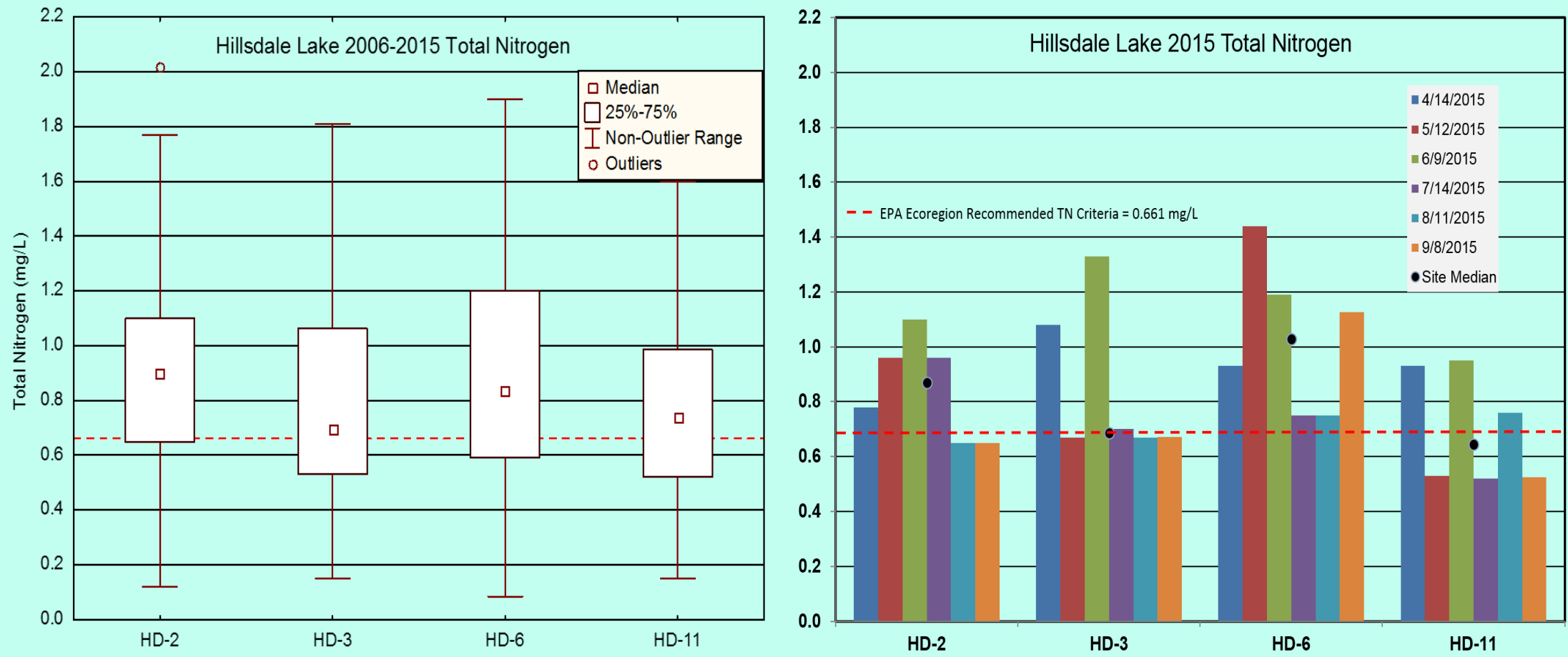
Total Phosphorus

Total phosphorus (TP) median values from 2015 Hillsdale Lake samples were higher than EPA Ecoregion recommended criteria (0.04 mg/L) and WRAPS 10-year goals (0.032 mg/L). Big Bull Creek and the HD-3 in by the tower were affected by inflows that measured 163% greater than 10-year average. Total phosphorus is highly correlated to stream discharge in inflows. Consequently, 2015 site median total phosphorus was higher than 75% of the records from 2006-2016. Median TP at all Hillsdale Lake sites are in the moderate to high range of biological productivity leading to high algae populations and rapid fish growth as indicated by TP, chlorophyll and secchi. Inflow events May-June were the primary influence on 2015 total phosphorus concentrations. Signs of internal loading is evident at HD-11 as TP increases monthly from May to August, which is a process that can increase algae bloom frequency during dry years.



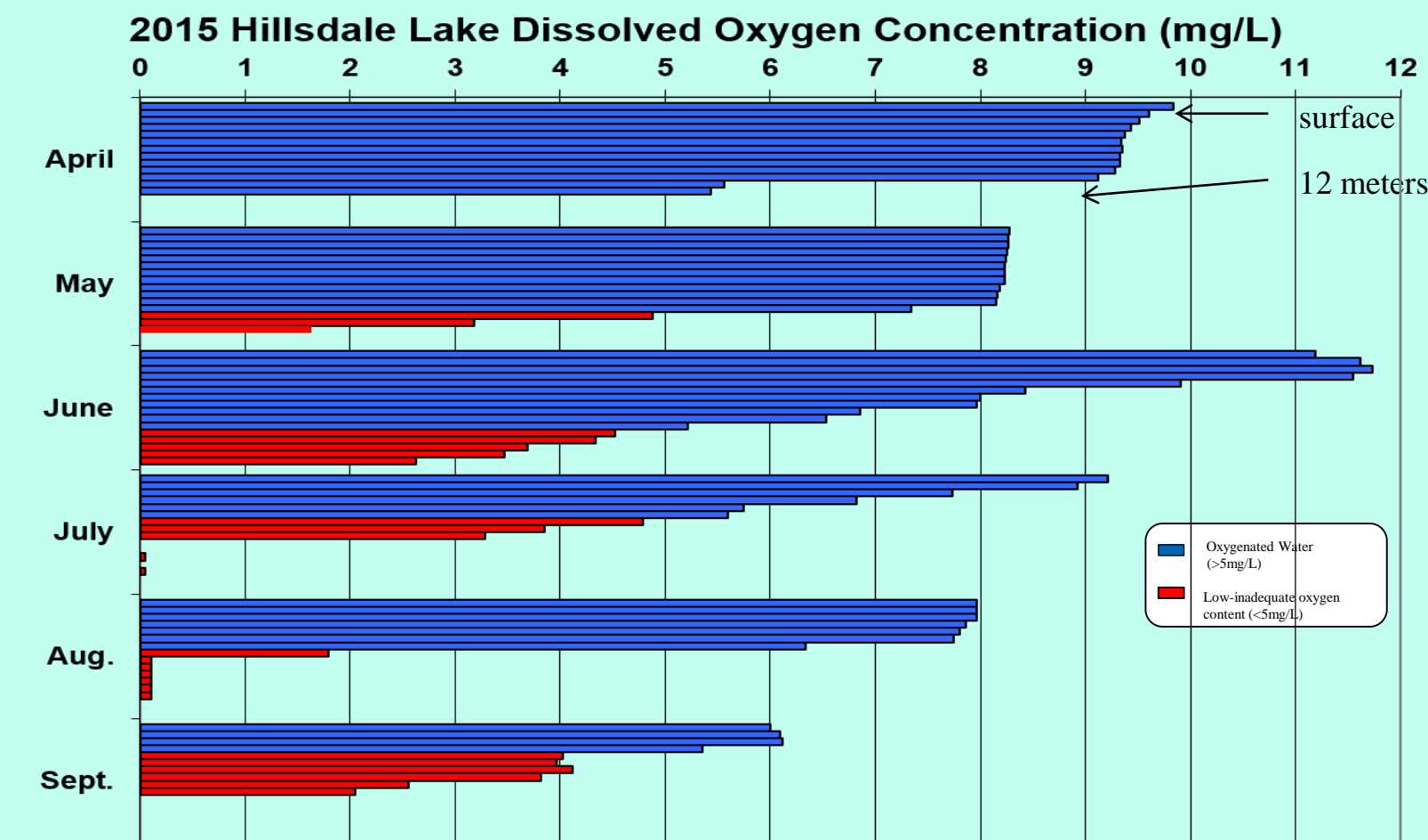
Total Nitrogen

Median total nitrogen concentrations at Hillsdale Lake are slightly above the EPA Ecoregion recommended criteria of 0.661 mg/L from 2006-2015. Total nitrogen values were highly variable by month in 2015 due to biological uptake by phytoplankton, non-point impacts on inflows, and other watershed influences. Big Bull arm of Hillsdale typically has higher nutrient and sediment concentrations than Little Bull or at the dam. Increasing phosphorus from internal and external loading combined with steady or decreasing TN has changed the TN:TP ratio at all lake sites to less than 20 from June-September which leads to competitive advantages for blue green algae species. This species shift can cause algae blooms and lead to toxin producing species.



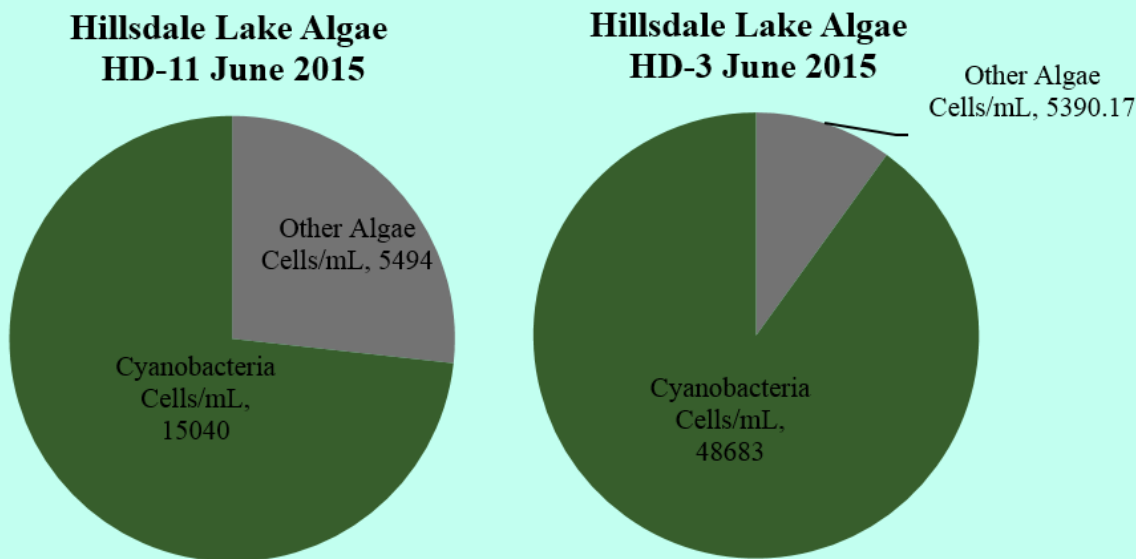
Dissolved Oxygen

Dissolved oxygen (D.O.) is an important factor in aquatic species location, growth, and ultimately survival in lakes. Some lakes undergo a process called stratification or develop layers based on temperature and oxygen. This process begins in late spring, remains throughout the summer, and breaks apart (i.e. de-stratifies or 'turns over') in the fall. The figure below shows dissolved oxygen measured in the water column in one-meter intervals (e.g. each row in each month represents one meter of depth) from April through September at the dam (HD3). Hillsdale Lake typically stratifies during summer months and lack of adequate (<5 mg/L) dissolved oxygen can stress fish. In 2015, Hillsdale Lake stratification was apparent May through September. During this period, the top 4 meters of Hillsdale Lake had sufficient oxygen and signs of fish stress was not reported.



Algae

Algae and green plants are the base of the food chain in a lake and function to convert nutrients and CO₂ via photosynthesis into biomass for all aquatic life. Hillsdale Lake algae populations are thriving with clear water allowing adequate sunlight penetration and an abundance of plant nutrients. June phytoplankton sampling collected during a visible algae bloom in June 2015 indicated that late summer algae populations were dominated by blue green algae at two sites. Algal cell counts were moderate according to World Health Organization guidelines with blue-green cell counts ranging from 15,000 to 48,000 cells/mL at lakes sites. USACE toxin samples did not detect algal toxins.



Water Quality Concerns:

- Eutrophication
- Dissolved Oxygen



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Environmental Resources Section
Kansas City, MO